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Abstract Title

Measures and Models for Estimating and Predicting Cognitive Fatigue

Abstract Body

We analyzed EEG and ERPs in a fatiguing mental task and created statistical models for single subjects. Seventeen subjects (4 F, 18-38 y) viewed 4-digit problems (e.g., 3+5-2+7=15) on a computer, solved the problems, and pressed keys to respond (intertrial interval = 1 s). Subjects performed until either they felt exhausted or three hours had elapsed. Pre- and post-task measures of mood (Activation Deactivation Adjective Checklist, Visual Analogue Mood Scale) confirmed that fatigue increased and energy decreased over time. We tested response times (RT); amplitudes of ERP components N1, P2, P300, readiness potentials; and amplitudes of frontal theta and parietal alpha rhythms for change as a function of time. For subjects who completed 3 h (n=9) we analyzed 12 15-min blocks. For subjects who completed at least 1.5 h (n=17), we analyzed the first-, middle-, and last 100 error-free trials. Mean RT rose from 6.7 s to 8.5 s over time. We found no changes in the amplitudes of ERP components. In both analyses, amplitudes of frontal theta and parietal alpha rose by 30% or more over time. We used 30-channel EEG frequency spectra to model the effects of time in single subjects using a kernel partial least squares classifier. We classified 3.5-s EEG segments as being from the first 100 or the last 100 trials, using random sub-samples of each class. Test set accuracies ranged from 63.9% to 99.6% correct. Only 2 of 17 subjects had mean accuracies lower than 80%. The results suggest that EEG accurately classifies periods of cognitive fatigue in 90% of subjects.

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